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Functional outcome of unstable clavicle fractures fixed with anatomical locking plate

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Abstract

Introduction: Fractures of Clavicle are high velocity injuries. Although many methods of treatment have been developed still controversy exists regarding the best treatment of unstable fractures.

Aim of the study: Recent studies of nonoperatively treated unstable clavicular fractures have shown a high incidence of non union and unsatisfactory functional outcome. Some studies have shown superior functional results and higher rates of healing following operative treatment. The goal of management of unstable fractures is stable fixation which lets early mobilization of the patient. The advantages and disadvantages of the intramedullary nailing and reconstruction plate have been established well in several studies in the past. In this context we used the pre contoured anatomical locking plate for the management of unstable clavicle fractures and evaluated the outcome of the fixation with anatomical locking plate.

Materials and Methods: Study between JUNE 2018 and OCTOBER 2019 in Department of Orthopaedics Rajah Muthiah Medical College, Annamalai University. 25 patients with closed unstable clavicular fractures were treated by Open reduction and internal fixation with anatomical locking plate. Results had been assessed by means of Constant Murley shoulder outcome score.

Results: The study period was three hundred and sixty five days. All clavicle fractures except one healed well with good functional outcome. The mean time for union was 12.76 weeks. One non union due to deep infection was encountered for a diabetic patient and was managed with implant removal, wound wash and antibiotics. 2 patients had screw pullout due to very early return to work before union. No implant failure and no other complications encountered in other cases.

Conclusion: In our study Anatomical locking plates for unstable clavicular fractures gives excellent outcome with a high rate of union, minor soft tissue injury, early return to the day to day activities.

Keywords: Clavicular fracture, anatomical locking plate, murley shoulder score

Introduction

Comminuted displaced midshaft Fractures of clavicle are common injuries across the shoulder girdle. Fractures of the clavicle account for about 2.6% of all fractures^[5]. Incidence in men is normally highest in second and 3rd decade which decreases thereafter as according to age. In ladies, it also includes bimodal, with high incidence in young and elderly. Allman classified fractures of clavicle into three primarily based on their location.

The middle-third fractures are common and account for approximately 85% of all clavicular fractures. The narrow segment of the bone in the middle of shaft combined with usual muscle forces acting over it predispose to fracture the bone on this locality. Further, Robinson modified Allman type primarily based on the displacement and comminution^[5]. The new classification provides a reliable and reproducible prognostic guide by identifying subgroups at risk of delayed or non union and other complications.

Most clavicle fractures generally unite with any approach of immobilization. Hence, non-operative treatment initially was the accepted modality of those fractures. But research have shown a high rate of non union and symptomatic malunion and shortening when the displaced fractures are treated conservatively^[1, 2, 3, 6]. Other shortcomings of non-operative treatment had been functional impairment of the shoulder and a non-cosmetic bump at the bottom of the neck possibly due to shortening and displacement of the clavicle and exuberant callus formation. Restoration of length and alignment achieved only by way of surgical strategies which are not

achieved by conservative treatment. Good outcome with high union rates and minimal complications has been mentioned with surgical fixation of the unstable clavicle fractures with anatomical locking plate.

However, operative management got its disadvantages like infection at surgical site, hypertrophic scar, hardware prominence and another surgical treatment for implant removal. In the more youthful age group, multiple injuries are also very not unusual and fractures of clavicle stays a frequent entity. In such situations, the choice of treatment stays a quandary for achieving maximum functional outcome.

Hence, in this study we endeavoured to find an evidence-based answer to opt for a ideal technique for the management of unstable clavicular fractures. The intention is to evaluate the functional results of unstable clavicle fractures managed with anatomical locking plate.

The implant used in all our patients was a pre-contoured 3.5 mm superior clavicle anatomical locking compression plate. Another set of 2.7 mm lag screws was always kept ready, in order to lag any unstable butterfly fragment(s), if the need arose.

Pre-operative planning

A written, informed consent was taken from all the patients for their inclusion in this study. All the patients were explained in detail the available methods of treatment, with the final treatment decision left to the patient.

A detailed history was taken, ascertaining the mode of injury, with particular emphasis placed on ruling out injuries to other areas. AP views of the involved shoulder were taken. Routine blood and radiological investigations were done, as required for anaesthetic clearance.

Materials and Methods

25 closed unstable fractures of clavicle admitted in our institute for the duration of 16 months (June 2018-October 2019) had been included in the study.

Inclusion criteria were age among 20 to 50, closed displacement >2cm unstable clavicle fracture with shortening > 2cm with or without comminution falling under Robinson category as kind 2B1 and 2B2, Segmental fractures, Open fracture, Impending compound fracture with soft tissue compromise, bilateral clavicular fractures.

Age <18 years and >60 years, Undisplaced or minimally displaced fractures, Any medical contraindication to surgery (Heart diseases, renal failure or active chemotherapy), Previous surgery of the clavicle, Pathological fractures other than osteoporosis, Patients managed conservatively for other scientific reasons, Ongoing chemotherapy or irradiation treatment because of malignancy, Patients who aren't able to give consent were excluded from the study.

Operative procedure

The surgery was performed under regional block or general anaesthesia when needed. The patient was positioned supine, with the head and neck tilted away from the surgical site with a bump placed behind the scapula to aid in reduction.

The arm was prepared in the field to allow for traction and manipulation to assist in the reduction. Pre-operative intravenous antibiotic (Cefotaxime 1 gram) was given to the patient, at least 30 minutes before making the skin incision. The skin inferior to the fracture site was incised after pulling it up to the fracture site. As the skin was released, it fell 1 to 2 cm below the clavicle and prevented the wound from being in contact with the plate on the clavicle. The subcutaneous tissue

and platysma muscle were kept together as one layer and extensively mobilized, especially proximally and distally. Sharp dissection was taken down to the bone, with care to identify, and if possible, preserve the cutaneous supraclavicular nerves. When deemed necessary, they were sacrificed. The myofascial layer over the clavicle was incised and elevated in one continuous layer comminuted fragments, especially the often seen anterosuperior fragment was teased back into position, as much as possible, maintaining its soft tissue attachments.

The fractured bone was reduced and the reduction held with the aid of reduction clamps. The pre-contoured plate was placed on the tension side of the bone-for the clavicle, this is the antero-superior position. Biomechanical studies have shown this position to provide best stability. The clavicle was drilled cautiously keeping in mind the relation of the subclavian vessels to the inferior surface to clavicle. Ideally 3 (atleast2) bicortical screws on either side of the fracture were needed; lag screws were used wherever needed to reduce the comminuted fragments. Once plating was completed, the fascia was repaired over the plate. Skin incision was closed. Antiseptic dressing was applied, and the arm was rested in an arm sling postoperative the patient was kept in the post-operative recovery ward, under observation. Vitals were monitored



Fig 1: Case Illustration 1

Early mobilization in the form of pendulum movements, elbow, wrist and finger mobilization exercises were allowed as soon as possible (typically 2-3 days). Sutures had been removed on 12 post-operative day. The sling was

discontinued after this and unrestricted range of motion physical activities have been allowed. Strengthening physical activities had been allowed after 6 weeks when radiograph confirmed bony union. If union was not turned into evident competitive sports had been avoided. Return to work and vigorous physical activities had been allowed after 12 weeks when radiograph confirms effective bony union.

Implant removal carried out on need to do basis. Patients were observed every month for first 3 months. Thereafter they had been followed at 6 months and twelve months. Radiographs had been taken at every visit. Both radiographic and clinical union had been assessed. Delayed union taken into consideration after four months. Outcomes were the assessed by constant score, and radiological evidence of union. Non union was defined as lack of callus formation, persistant fracture lines, and/or sclerotic edges of bone at the fracture site at six months. Other parameters studied have been infection, wound dehiscence, implant failure, non-union, delayed union, implant prominence.

side clavicle fracture is more common than left side (15:10). Road traffic accident is the most common cause followed by accidental fall (19:6). Of the 25 patients, 8 patients had a Robinson type 2B1 fracture configuration, whereas the 17 other patients had a type 2B2 configuration. The patients were taken to surgery within 10 days after injury. The average duration of hospital stay was 12 days. In our study time taken for fracture union ranges from 10 weeks to 18 weeks. Mean union time was 12.76 weeks. Union was assessed by the presence of bridging cortices on AP X-ray and painless range of motion of the shoulder.

Table 1: Time of Union

| Time of Union | No. of Patients |
|---------------|-----------------|
| 10 weeks | 02 |
| 12-14 weeks | 14 |
| 16 | 6 |
| 18 | 2 |
| >18 weeks | 01 |

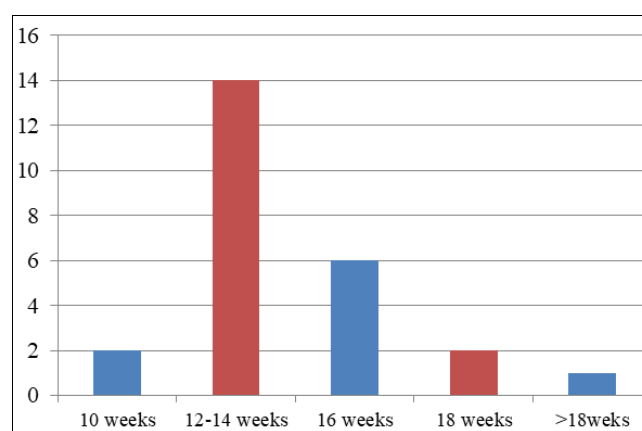


Chart 1: Time of Union



Fig 2: Case Illustration 2

Results

In our study average age ranges from 19 to 45 years. Male preponderance of 19 compared to 9 female patients. Right

All clavicle fractures except one united well with good functional outcome. One case got deep surgical site infection due to uncontrolled diabetes and was managed with implant removal, wound wash and antibiotics. Finally it went for non union. 2 patient had hardware prominence due to screw pull out not warrants urgent implant removal and among this one had numbness below the clavicle. No other complications had been found in other cases.

Complications

Table 2: Complications

| | |
|----------------------|---|
| Hard ware prominence | 2 |
| Screw pullout | 2 |
| Infection | 1 |
| Delayed union | 0 |
| Nonunion | 1 |
| Mal union | 0 |
| Hard ware failure | 0 |
| Re fracture | 0 |
| Paraesthesia | 1 |

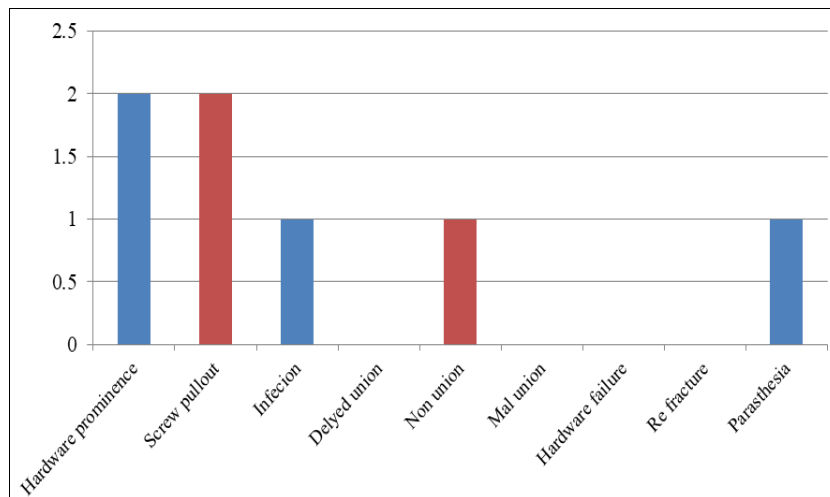


Chart 2: Complications



Fig 3: Hardware prominence and paresthesia

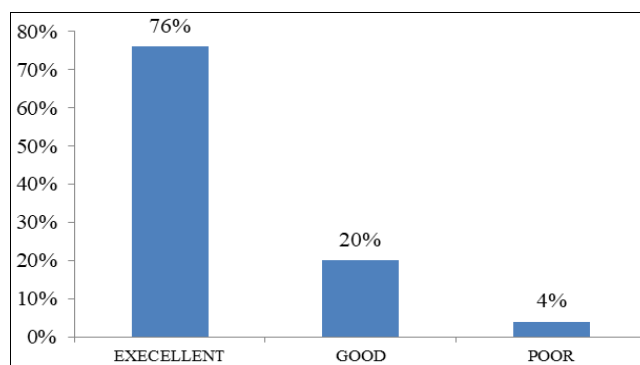


Chart 3: Outcome

Results are assessed by constant Murley shoulder score

- Pain (15 points)
- Activity level (20 points)
- Strength of abduction (pounds) (25 points)
- Range of motion (40 points)

Table 4: Constant score

| Constant score | No |
|----------------|---------|
| Satisfactory | 24(96%) |
| Unsatisfactory | 1(4%) |



Fig 4: Screw pull out

Outcome was excellent in 19 patients, good in 5 patients and poor in 1 patient as assessed by constant score.

Table 3: Outcome

| Outcome | Number |
|-----------|---------|
| Excellent | 19(76%) |
| Good | 5(20%) |
| Poor | 1(4%) |

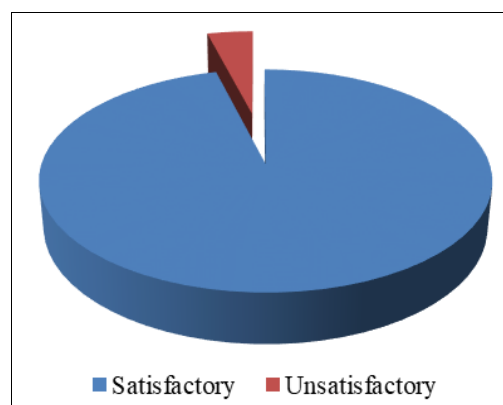


Chart 4: Constant score

Discussion

Clavicle fractures are normally treated conservatively [14, 18, 31]. In a study conducted to analyze the results of conservative treatment of displaced midshaft fractures of clavicle by Michael *et al.* [6] they detected residual deficits in shoulder strength, especially endurance strength, in this patient

population. They also found clavicular shortening [3, 16] was associated with a decreased abduction strength, and shortening of >2cm was associated with a patient dissatisfaction. In a study by Anders nordqvist [30] regarding shortening they found permanent shortening is common after fracture after conservative management but has no clinical significance. So for particular indications, like displacement with or without comminution in unstable clavicle fracture (Robinson Type-2B1, 2B2), non-operative method isn't always most appropriate. In a meta-analysis of randomized clinical trials by Robbin C. Mckee *et al.* [12], they found operative treatment provided a significantly lower rate of non union and symptomatic malunion and an earlier functional return compared with non operative treatment. Hill *et al.* [2] reported an unsatisfactory outcome after the conservative treatment of 16 of 52 fractures.

A.H Qvist *et al.* [1] compared plate fixation with non operative treatment of displaced midshaft clavicular fractures and concluded precontoured and locking plates results in faster functional recovery and a higher rate of union when compared with non operative management [1].

Micheal *et al.* [7, 32, 33] performed a study on malunited midshaft clavicle fractures. They identified 12 of 15 patients had weakness and pain in the involved shoulder for which corrective osteotomy was done. This study confirms the prevalence of malunion and disability of unstable fracture clavicle after conservative management. Symptomatic patients are typically those with marked displacement at fracture site, especially shortening. Patients reported weakness of the involved shoulder, rapid fatigability, numbness and paresthesias of the hand and forearm with elevation of the limb and an asymmetric droopy shoulder.

Over the past decades the operative treatment of displaced fractures of clavicle has increased. Two of the most commonly used techniques for operative treatment are open reduction and internal fixation with plate and intramedullary nail fixation. Nidhi narsaria [20] in his study found elastic intramedullary nailing is a safe, minimally invasive technique with a lower complication rate but Arno frigg [26] and others studied about the complications like nail breakage, medial migration, hardware irritation. The sigmoid shape of the clavicle [4] poses specific problem in the design and insertion of intramedullary devices and static locking is not possible with the implants currently available. There is biomechanical evidence to suggest that plate fixation provides a stronger construct than intramedullary fixation [11, 15].

Functional results of unstable clavicle fractures isn't simply related to its union, but additionally to its length. To maintain the length plate is the ideal implant than a nail [21, 29]. Clavicle acts as a "strut" that keeps the upper limb away from the torso for efficient shoulder and upper limb function, while also transmitting forces from limb to the trunk. Thus, displaced or comminuted fractures carry a chance of symptomatic malunion and poor functional outcome with cosmetic deformity. Plate fixation provides immediate rigid stabilization and pain relief and facilitates early mobilization [12, 19]. Most commonly the plate is implanted on the superior aspect of clavicle. Currently the implants most commonly used are locking plates. Reconstruction plates have fallen into disfavor, since they are susceptible to deformation at the fracture site, leading to malunion. In study by J-W Shen [24] and others concluded a three dimensional reconstruction plate is better than 2D plate which is placed superiorly.

To overcome this Site specific precontoured locking plates are now available. Hardware prominence was less when

precontoured plate was used. Tania Reisch *et al.* [17] in their research in 100 patients found the new precontoured locking plate fit to the anatomical shape of the clavicle. The implant seems to be reliable regarding handling and complications. Hardware removal rates are comparable to other studies with a pre-contoured plate and lower compared to non pre-contoured. In a study by Alexander *et al.* [27] they found the precontoured plates significantly diminish hardware prominence. In another study by Luanhai Ou *et al.* [13] cutaneous paresthesia after internal plate fixation of clavicle fractures and underlying anatomical variations were analysed. They concluded cutaneous hyposthesia may be caused by injury to the supraclavicular nerve resulting from the fracture or from the surgery itself. Careful exposure and delamination of these nerves during surgery can protect the nerve, resulting in satisfactory postoperative outcomes [25].

There was a controversy regarding antero inferior and superior position of plate during internal fixation. Corine van beck *et al.* [28] compared superior plating of non contoured and pre contoured plating and found superior precontoured plates have low incidence of plate prominence and hardware removal. So in our study we fixed unstable clavicular fractures with superior pre contoured plate. M. Ashanwani *et al.* [8] analysed functional results of superior pre contoured plate [22, 23]. The latest trend is shifting in the direction of internal fixation of those unstable clavicle fractures with anatomical locking plate [9, 10]. A prospective study was carried in Department of orthopaedics, Rajah Muthiah medical college, Annamalai University from June 2018 to October 2019. The mean age in our study was 25.6 years. Males predominate in our study. The mean time to union in our study was 12.76 weeks, from the date of surgery. Previous studies noted road traffic accident was the commonest cause of the clavicle fractures. In our study also, we found that the most common cause of sustaining these injuries were road traffic accidents. Our report of two cases (8%) troubled with hardware irritation [34] due to screw pull out is much lower than other studies. Infraclavicular paraesthesia present in one of these patient due to supraclavicular nerve injury. One case got deeply infected (4%) [35] due to uncontrolled sugar values which was initially managed with wound debridement and antibiotics. After 5 months the implant was removed and wound was settled but the fracture went for non union. But the patient had a useful painless range of movements.

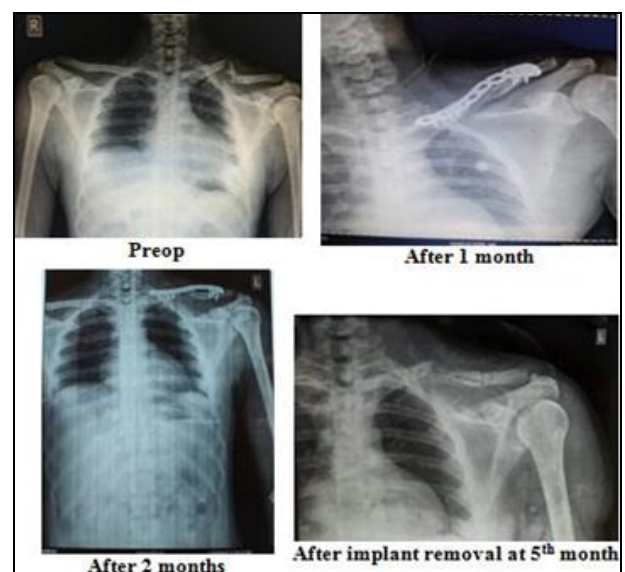


Fig 5: Case Illustration 3



Fig 6: Patient complicated by infection

In our study, time to union was shorter with good union rates. More patients have been satisfied and subjective outcome was higher. The Constant shoulder rankings have been also significantly higher in follow-ups.

Conclusion

So, we will conclude from our study that anatomical locking plates gave good functional results in unstable clavicle fractures. We advocate the usage of anatomical locking plates for internal fixation of unstable clavicle fractures. Since one case got infected and went for non union due to high blood sugar values we recommend anatomical locking plate to be used very cautiously in diabetic patients. We also recommend minimum 3 screws on either side of the fracture if possible. Also we concluded proper reduction and stable fixation gives excellent outcome with anatomical locking plate.

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